Quick Start Guide

Class 1 laser CMOS sensor with a discrete (PNP or NPN) output. Patent pending.

This guide is designed to help you set up and install the Q4X Sensor. For complete information on programming, performance, troubleshooting, dimensions, and accessories, please refer to the Instruction Manual at www.bannerengineering.com. Search for p/n 181483 to view the Instruction Manual. Use of this document assumes familiarity with pertinent industry standards and practices.

For illustration purposes, the threaded barrel model Q4X images are used throughout this document.

WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

Features

1. Output Indicator (Amber)
2. Display
3. Buttons

Display and Indicators

The display is a 4-digit, 7-segment LED. The main screen is the Run mode screen.

For 2-pt, BGS, FGS, and DYN TEACH modes, the display shows the current distance to the target in millimeters. For dual TEACH mode, the display shows the percentage matched to the taught reference surface. A display value of 999 indicates the sensor has not been taught.

Output Indicator
- On—Outputs conducting (closed)
- Off—Outputs not conducting (open)

Stability Indicator (STB)
- On—Stable signal within the specified sensing range
- Flashing—Marginal signal, the target is outside the limits of the specified sensing range, or a multiple peak condition exists
- Off—No target detected within the specified sensing range

Active TEACH Indicators (DYN, FGS, and BGS)
- DYN—Dynamic (Amber)
- FGS—Foreground Suppression (Amber)
- BGS—Background Suppression (Amber)

Output Indicator
- On—Outputs conducting (closed)
- Off—Outputs not conducting (open)

Stability Indicator (STB)
- On—Stable signal within the specified sensing range
- Flashing—Marginal signal, the target is outside the limits of the specified sensing range, or a multiple peak condition exists
- Off—No target detected within the specified sensing range

Active TEACH Indicators (DYN, FGS, and BGS)
- DYN—Dynamic TEACH mode selected
- FGS—Foreground suppression TEACH mode selected
- BGS—Background suppression TEACH mode selected
- DYN, FGS, and BGS all on—Dual TEACH mode selected
Buttons

Use the sensor buttons (SELECT)(TEACH), (+)(DISP), and (-)(MODE) to program the sensor.

(_SELECT)(TEACH)
- Press to select menu items in Setup mode
- Press and hold for longer than 2 seconds to start the currently selected TEACH mode (the default is two-point TEACH)

(+)(DISP)
- Press to navigate the sensor menu in Setup mode
- Press to change setting values; press and hold to increase numeric values
- Press and hold for longer than 2 seconds to switch between light operate (LO) and dark operate (DO)

(-)(MODE)
- Press to navigate the sensor menu in Setup mode
- Press to change setting values; press and hold to decrease numeric values
- Press and hold for longer than 2 seconds to enter Setup mode

Note: When navigating the menu, the menu items loop.

Laser Description and Safety Information

CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Do not attempt to disassemble this sensor for repair. A defective unit must be returned to the manufacturer.

Class 1 Lasers

Class 1 lasers are lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.

Laser wavelength: 655 nm
Output: < 0.20 mW
Pulse Duration: 7 µs to 2 ms

Installation

Install the Safety Label

The safety label must be installed on Q4X sensors that are used in the United States.

Note: Position the label on the cable in a location that has minimal chemical exposure.

1. Remove the protective cover from the adhesive on the label.
2. Wrap the label around the Q4X cable, as shown.
3. Press the two halves of the label together.

Note: When navigating the menu, the menu items loop.
Sensor Orientation

Optimize detection reliability and minimum object separation performance with correct sensor-to-target orientation. To ensure reliable detection, orient the sensor as shown in relation to the target to be detected.

See the following figures for examples of correct and incorrect sensor-to-target orientation as certain placements may pose problems for sensing some targets. The Q4X can be used in the less preferred orientation and provide reliable detection performance; refer to the Performance Curves for the minimum object separation distance required for each case.

Mount the Sensor

1. If a bracket is needed, mount the sensor onto the bracket.
2. Mount the sensor (or the sensor and the bracket) to the machine or equipment at the desired location. Do not tighten the mounting screws at this time.
3. Check the sensor alignment.
4. Tighten the mounting screws to secure the sensor (or the sensor and the bracket) in the aligned position.

Wiring Diagram—Threaded Barrel Models

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Note: Open lead wires must be connected to a terminal block.

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Applying tilt to sensor may improve performance on reflective targets. The direction and magnitude of the tilt depends on the application, but a 15° tilt is often sufficient.
Wiring Diagram—Flush Mount Models

Note: The input wire function is user-selectable; see the Instruction Manual for details. The default for the input wire function is off (disabled).

**NPN Models**

<table>
<thead>
<tr>
<th>1 = Brown</th>
<th>2 = White</th>
<th>3 = Blue</th>
<th>4 = Black</th>
</tr>
</thead>
</table>

10-30 V dc

**PNP Models**

10–30 V dc

Key

1 = Brown
2 = White
3 = Blue
4 = Black

Note: Open lead wires must be connected to a terminal block.

Note: The input wire function is user-selectable; see the Instruction Manual for details. The default for the input wire function is off (disabled).

Cleaning and Maintenance

Handle the sensor with care during installation and operation. Sensor windows soiled by fingerprints, dust, water, oil, etc. may create stray light that may degrade the peak performance of the sensor. Blow the window clear using filtered, compressed air, then clean as necessary using water and a lint-free cloth.

Sensor Programming

Program the sensor using the buttons on the sensor or the remote input (limited programming options).

In addition to programming the sensor, use the remote input to disable the buttons for security, preventing unauthorized or accidental programming changes. See the Instruction Manual, p/n 181483 for more information.

Setup Mode

Access Setup mode and the sensor menu from Run mode by pressing and holding **MODE** for longer than 2 seconds. Use **+** and **−** to navigate through the menu. Press **SELECT** to select a menu option and access the submenus. Use **+** and **−** to navigate through the submenus. Press **SELECT** to select a submenu option and return to the top menu, or press and hold **SELECT** for longer than 2 seconds to select a submenu option and return immediately to Run mode.

To exit Setup mode and return to Run mode, navigate to **End** and press **SELECT**.
Two-point static BGS
Dynamic BGS
One-point Window (FGS)
One-point BGS
Dual, intensity + distance

Set Response Speed to 1.5 ms
Set Response Speed to 3 ms
Set Response Speed to 10 ms
Set Response Speed to 25 ms
Set Response Speed to 50 ms
(1. Default response speed for 500 mm bipolar model)

Gain menu is available when Response Speed is set to 10, 25 or 50 ms
* Adaptive Tracking menu is available when Teach Process is set to Dual Mode
† Select Zero Reference menu is not available when in Dual Mode
‡ Shift Zero Reference menu is not available when in Dual Mode

Adaptive Tracking menu is available when Teach Process is set to Dual Mode
High-Speed Adaptive Tracking ON
Adaptive Tracking ON
Adaptive Tracking OFF

Gain and Sensitivity**
High excess gain mode
Standard excess gain with increased noise immunity
** Gain menu is available when Response Speed is set to 10, 25 or 50 ms

Near: set zero displayed value to end of 18 mm barrel
Far: set zero displayed value to maximum detection range

On: move the zero point after each teach
Off: zero point is either at end of barrel or maximum detection range
† Shift Zero Reference menu is not available when in Dual Mode

Laser off when pulled low
Laser on when pulled low
Laser off when pulled low
Laser on when pulled low

Set: Remote Teach input
Off: remote teach input is not active

Display on
Display on, inverted
Display off (enters sleep mode after 60 seconds)
Display off, inverted (enters sleep mode after 60 seconds)

End: select to exit setup
End: to exit setup

No: do not reset to factory defaults
Yes: reset to factory defaults

Figure 11. Sensor Menu Map—Channel 1
Basic TEACH Instructions

Use the following instructions to teach the Q4X sensor. The instructions provided on the sensor display vary depending on the type of TEACH mode selected. Two-point TEACH is the default TEACH mode.

1. Press and hold TEACH for longer than 2 seconds to start the selected TEACH mode.
2. Present the target.
3. Press TEACH to teach the target. The target is taught and the sensor waits for the second target, if required by the selected TEACH mode, or returns to Run mode.

Complete steps 4 and 5 only if required for the selected TEACH mode:
4. Present the second target.
5. Press TEACH to teach the target. The target is taught and the sensor returns to Run mode.

See the Instruction Manual for detailed instructions and other available TEACH modes. The TEACH modes include:

- **Two-point static background suppression** — Two-point TEACH sets a single switch point. The sensor sets the switch point between two taught target distances, relative to the shifted origin location.
- **Dynamic background suppression** — Dynamic TEACH sets a single switch point during machine run conditions. The sensor takes multiple samples and the switch point is set between the minimum and the maximum sampled distances.
- **One-point window (foreground suppression)** — One-point window sets a window (two switch points) centered around the taught target distance.
- **One-point background suppression** — One-point background suppression sets a single switch point in front of the taught target distance. Objects beyond the taught switch point are ignored.
- **Dual intensity + distance** — Dual mode records the distance and amount of light received from the reference surface. See Dual Mode Reference Surface Considerations on page 10 for more information about selecting a reference surface. The output switches when an object passing between the sensor and the reference surface changes the perceived distance or amount of returned light.

Manual Adjustments

Manually adjust the sensor switch point using the and buttons.

1. From Run mode, press either or one time. The current switch point value flashes slowly.
2. Press to move the switch point up or to move the switch point down. After 1 second of inactivity, the new switch point value flashes rapidly, the new setting is accepted, and the sensor returns to Run mode.

**Note:** When FGS mode is selected (FGS indicator is on), manual adjustment moves both sides of the symmetrical threshold window simultaneously, expanding and collapsing the window size. Manual adjustment does not move the center point of the window.

**Note:** When dual mode is selected (DYN, FGS, and BGS indicators are on), after the TEACH process is completed, use the manual adjustment to adjust the sensitivity of the thresholds around the taught reference point. The taught reference point is a combination of the measured distance and returned signal intensity from the reference target. Manual adjustment does not move the taught reference point, but pressing increases the sensitivity, and pressing decreases the sensitivity. When re-positioning the sensor or changing the reference target, re-teach the sensor.

Light Operate/Dark Operate

The default output configuration is light operate. To switch between light operate and dark operate, use the following instructions:

1. Press and hold LO/DO for longer than 2 seconds. The current selection displays.
3. Press SELECT to change the output configuration and return to Run mode.

**Note:** If neither SELECT nor LO/DO are pressed after step 2, the new selection flashes slowly for a few seconds, then flashes quickly and the sensor automatically changes the output configuration and returns to Run mode.

Locking and Unlocking the Sensor Buttons

Use the lock and unlock feature to prevent unauthorized or accidental programming changes. Three settings are available:

- **LOC** — The sensor is unlocked and all settings can be modified (default).
- **LOC** — The sensor is locked and no changes can be made.
- The switch point value can be changed by teaching or manual adjustment, but no sensor settings can be changed through the menu.

When in loc mode, loc displays when the (SELECT)(TEACH) button is pressed. The switch point displays when (+)(DISP) or (-)(MODE) are pressed, but loc displays if the buttons are pressed and held.

When in loc mode, loc displays when (+)(DISP) or (-)(MODE) are pressed and held. To access the manual adjust options, briefly press and release (+)(DISP) or (-)(MODE). To enter TEACH mode, press the (SELECT)(TEACH) button and hold for longer than 2 seconds.

To enter loc mode, hold loc and press four times. To enter loc mode, hold loc and press loc seven times. Holding loc and pressing loc four times unlocks the sensor from either lock mode and the sensor displays uloc.

**Specifications**

- Sensing Beam: Visible red Class 1 laser, 655 nm
- Supply Voltage (Vcc): 10 to 30 V dc
- Power and Current Consumption, exclusive of load: < 675 mW
- Sensing Range—Threaded Barrel Models:
  - 500 mm models: 25 mm to 500 mm (0.98 in to 19.69 in)
  - 300 mm models: 25 mm to 300 mm (0.98 in to 11.81 in)
  - 100 mm models: 25 mm to 100 mm (0.98 in to 3.94 in)
- Sensing Range—Flush Mount Models:
  - 310 mm models: 35 mm to 310 mm (1.38 in to 12.20 in)
  - 110 mm models: 35 mm to 110 mm (1.38 in to 4.33 in)
- Output Configuration:
  - Threaded Barrel Models: Bipolar (1 PNP and 1 NPN) output
  - Flush Mount Models: PNP or NPN output, depending on model
- Output Rating:
  - 100 mA total maximum (protected against continuous overload and short circuit)
  - Off-state leakage current: < 5 µA at 30 V dc
  - PNP On-state saturation voltage: < 1.5 V dc at 100 mA load
  - NPN On-state saturation voltage: < 1.0 V dc at 100 mA load
- Discrete Output Distance Repeatability:
  - Table 1: Discrete Output Repeatability—300/310 mm and 500 mm Models
  - Table 2: Discrete Output Repeatability—100/110 mm Models
- Remote Input:
  - Allowable Input Voltage Range: 0 to Vcc
  - Active Low (internal weak pullup—sinking current): Low State < 2.0 V at 1 mA max.
- Supply Protection Circuitry:
  - Protected against reverse polarity and transient overvoltages

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1. ex: 15 excess gain available in 10 ms, 25 ms, and 50 ms response speeds only
2. ex: excess gain provides increased noise immunity
3. ex: excess gain available in 10 ms, 25 ms, and 50 ms response speeds only
4. ex: excess gain provides increased noise immunity

Table 3: Excess Gain

<table>
<thead>
<tr>
<th>Response Speed (ms)</th>
<th>Excess Gain—90% White Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>at 25 mm</td>
<td>at 100 mm at 300 mm at 500 mm</td>
</tr>
<tr>
<td>1.5</td>
<td>200 100 20 7</td>
</tr>
<tr>
<td>3</td>
<td>200 100 20 7</td>
</tr>
<tr>
<td>10</td>
<td>1000 (500) 500 (250) 100 (50) 36 (18)</td>
</tr>
<tr>
<td>25</td>
<td>2500 (1500) 1250 (650) 250 (100) 90 (36)</td>
</tr>
<tr>
<td>50</td>
<td>5000 (2500) 2500 (1250) 500 (250) 180 (90)</td>
</tr>
</tbody>
</table>

Table 4: Excess Gain

<table>
<thead>
<tr>
<th>Response Speed (ms)</th>
<th>Excess Gain—90% White Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>at 25 mm</td>
<td>at 100 mm at 300 mm at 500 mm</td>
</tr>
<tr>
<td>1.5</td>
<td>200 100 20 7</td>
</tr>
<tr>
<td>3</td>
<td>200 100 20 7</td>
</tr>
<tr>
<td>10</td>
<td>1000 (500) 500 (250) 100 (50)</td>
</tr>
<tr>
<td>25</td>
<td>2500 (1500) 1250 (650) 250 (100)</td>
</tr>
<tr>
<td>50</td>
<td>5000 (2500) 2500 (1250) 500 (250)</td>
</tr>
</tbody>
</table>
Beam Spot Size—300/310 mm and 500 mm Models

Table 5: Beam Spot Size—300/310 mm and 500 mm Models

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Threaded Barrel Models</th>
<th>Flush Mount Models</th>
<th>Size (Horizontal × Vertical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>35</td>
<td></td>
<td>2.6 mm × 1.0 mm</td>
</tr>
<tr>
<td>150</td>
<td>160</td>
<td></td>
<td>2.3 mm × 0.9 mm</td>
</tr>
<tr>
<td>300</td>
<td>310</td>
<td></td>
<td>2.0 mm × 0.8 mm</td>
</tr>
<tr>
<td>500</td>
<td>-</td>
<td></td>
<td>1.9 mm × 1.0 mm</td>
</tr>
</tbody>
</table>

Beam Spot Size—100/110 mm Models

Table 6: Beam Spot Size—100/110 mm Models

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Threaded Barrel Models</th>
<th>Flush Mount Models</th>
<th>Size (Horizontal × Vertical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>35</td>
<td></td>
<td>2.4 mm × 1.0 mm</td>
</tr>
<tr>
<td>50</td>
<td>60</td>
<td></td>
<td>2.2 mm × 0.9 mm</td>
</tr>
<tr>
<td>100</td>
<td>110</td>
<td></td>
<td>1.8 mm × 0.7 mm</td>
</tr>
</tbody>
</table>

Delay at Power Up
< 750 ms

Maximum Torque
- Side mounting: 1 N·m (9 in-lbs)
- Nose mounting: 20 N·m (177 in-lbs)

Ambient Light Immunity
- > 5,000 lux at 300 mm
- > 2,000 lux at 500 mm

Connector
- Threaded Barrel Models: Integral 5-pin M12/Euro-style quick disconnect
- Flush Mount Models: Integral 4-pin M12/Euro-style quick disconnect

Construction
- Housing: 316 L stainless steel
- Lens cover: PMMA acrylic
- Lightpipe and display window: polysulfone

Environmental Rating
- IEC IP67 per IEC60529
- IEC IP68 per IEC60529
- DIN IP69K per DIN40050-9

Vibration
- MIL-STD-202G, Method 201A (Vibration: 10 Hz to 60 Hz, 0.06 inch (1.52 mm) double amplitude, 2 hours each along X, Y and Z axes), with unit operating

Shock
- MIL-STD-202G, Method 213B, Condition I (100G 6x along X, Y and Z axes, 18 shocks), with sensor operating

Operating Conditions
- –10 °C to +50 °C (+14 °F to +122 °F)
- 35% to 95% relative humidity

Storage Temperature
- –25 °C to +75 °C (–13 °F to +167 °F)

Required Overcurrent Protection

<table>
<thead>
<tr>
<th>Supply Wiring (AWG)</th>
<th>Required Overcurrent Protection (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5.0</td>
</tr>
<tr>
<td>22</td>
<td>3.0</td>
</tr>
<tr>
<td>24</td>
<td>2.0</td>
</tr>
<tr>
<td>26</td>
<td>1.0</td>
</tr>
<tr>
<td>28</td>
<td>0.8</td>
</tr>
<tr>
<td>30</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Certifications

- ECOLAB® certified
- UL Environmental Rating: Type 1

Overcurrent protection is required to be provided by end product application per the supplied table.

For additional product support, go to www.bannerengineering.com.
Performance Curves—Threaded Barrel Models

Minimum Separation Distance Between Target and Background for: Uniform and Non-Uniform Targets

100 mm Models

Matte targets with uniform reflectivity: 6% to 90%
Matte targets with non-uniform reflectivity: 6% to 90%

300 mm Models

Matte targets with uniform reflectivity: 6% to 90%
Matte targets with non-uniform reflectivity: 6% to 90%

500 mm Models

Matte targets with uniform reflectivity: 6% to 90%
Matte targets with non-uniform reflectivity: 6% to 90%

Figure 12. Minimum Object Separation Distance (90% to 6% reflectance)
Performance Curves—Flush Mount Models

Minimum Separation Distance Between Target and Background for: Uniform and Non-Uniform Targets

**110 mm Models**

<table>
<thead>
<tr>
<th>Distance to Target (mm)</th>
<th>Dimension X</th>
<th>Dimension Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>75</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td>100</td>
<td>8</td>
<td>2.0</td>
</tr>
<tr>
<td>110</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>125</td>
<td>12</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Matte targets with uniform reflectivity: 6% to 90%

Flush Mount Models

Target

Background

Switch Point Distance

**310 mm Models**

<table>
<thead>
<tr>
<th>Distance to Target (mm)</th>
<th>Dimension X</th>
<th>Dimension Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>75</td>
<td>7</td>
<td>1.0</td>
</tr>
<tr>
<td>100</td>
<td>9</td>
<td>1.5</td>
</tr>
<tr>
<td>125</td>
<td>11</td>
<td>2.0</td>
</tr>
<tr>
<td>150</td>
<td>13</td>
<td>2.5</td>
</tr>
<tr>
<td>175</td>
<td>15</td>
<td>3.0</td>
</tr>
<tr>
<td>200</td>
<td>17</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Matte targets with non-uniform reflectivity: 6% to 90%

Dual Mode Reference Surface Considerations

Optimize reliable detection by applying these principals when selecting your reference surface, positioning your sensor relative to the reference surface, and presenting your target. The robust detection capabilities of the Q4X allows successful detection even under non-ideal conditions in many cases. Typical reference surfaces are metal machine frames, conveyor side rails, or mounted plastic targets. Contact Banner Engineering if you require assistance setting up a stable reference surface in your application. For detailed instructions for detecting clear or transparent objects, refer to the Instruction Manual, p/n 181483.

1. Select a reference surface with these characteristics where possible:
   - Matte or diffuse surface finish
   - Fixed surface with no vibration
   - Dry surface with no build-up of oil, water, or dust
2. Position the reference surface between 50 mm and the maximum sensing range for threaded barrel models or between 60 mm and the maximum sensing range for flush mount models.
3. Position the target to be detected as close to the sensor as possible, and as far away from the reference surface as possible.
4. Angle the sensing beam relative to the target and relative to the reference surface 10 degrees or more.
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